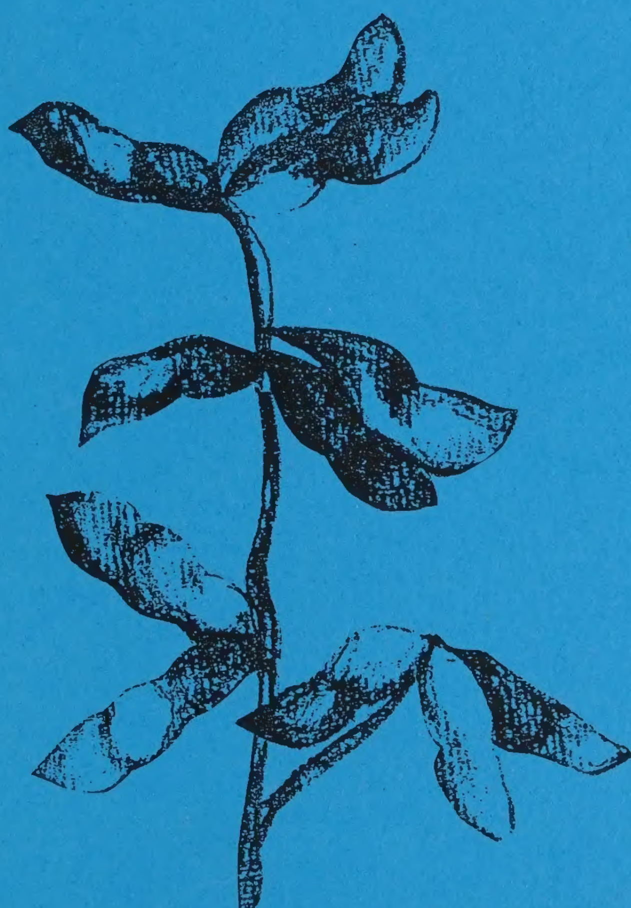
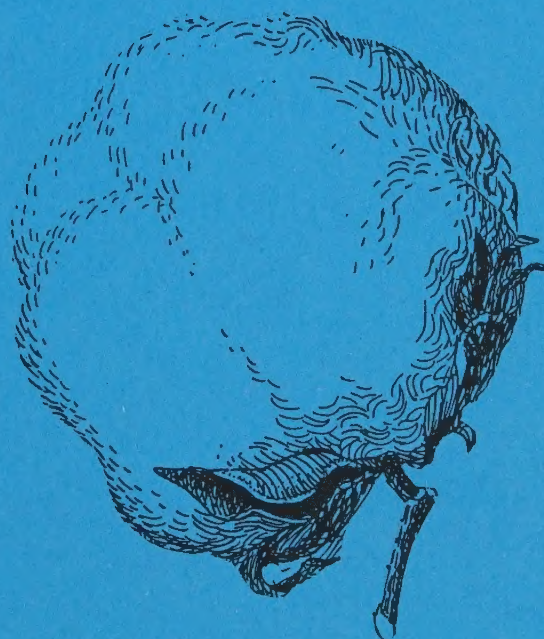
SOUTHERN INSECT MANAGEMENT LABORATORY USDA/ARS

Stoneville, Mississippi





Annual Report on Progress (CY 1992) and Plans (CY 1993)

CONTENTS

I. Introduction

This report summarizes progress made on various research objectives in 1992 and presents plans for 1993.

Many of the results are preliminary and others are being released through established channels. Therefore, this report is not intended for publication and should not be referred to in literature citations.

The intent of this report is to give the reader an overview of Southern Insect Management Laboratory (SIML) research activities. These activities (progress and plans) address the laboratory and unit missions (listed on pages 4-7). To accomplish the mission, the Laboratory is divided into one unit at Stoneville (Southern Insect Management Research Unit (SIMRU)) and one unit at Mississippi State (Insect Rearing Research Unit (IRRU)) which is housed in the R. T. Gast Rearing Laboratory.

SIML activities are centered around seven research thrusts, which reflect present CRIS work units. These are:

(1) Biological and genetic control of crop insect pests, emphasizing *Heliothis*/*Helicoverpa*;

(2) Population ecology of insect pests for integrated control/management systems;

(3) Biology, ecology, and behavior of plant bugs and cotton aphids;

(4) Strategies for managing crop insects, emphasizing the cotton agroecosystem and pesticide effectiveness;

(5) Integrated control of pecan pests;

(6) Host plant resistance in soybean pests; and

(7) Mass propagation technology for the boll weevil, *Heliothis*/*Helicoverpa*, and *Microplitis croceipes* (Cresson).

The first through sixth areas are researched by the SIMRU and the seventh by the IRRU.

This report is divided into four sections:

(1) Report on research progress in CY 1992;

(2) List of publications including those in press and accepted for publication;

(3) Other indicators of progress such as presentations and papers in manuscript; and

(4) Plans for CY 1993.

In each section, items are arranged by researcher (in alphabetical order of lead scientist; the name of lead scientist and cooperating and/or collaborating researchers are provided for each item). If the reader has questions pertaining to the item, he/she should contact the individual scientist, research leader, or laboratory director.

II. Mission Statement and Staff

SOUTHERN INSECT MANAGEMENT LABORATORY
ARS/USDA, Mid South Area
Stoneville, Mississippi 38776
Telephone: Comm. 601-686-5231
FTS: 700-497-2231
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OFFICE OF LABORATORY DIRECTOR

Mission:

The mission of the Southern Insect Management Laboratory is to conduct fundamental research on the biology, ecology, and rearing of field crop and pecan insect pests and their natural enemies; develop innovative biological, genetic, cultural, and chemical methods for suppressing insect pests; and integrate this knowledge into insect management systems. A goal of this laboratory is to develop new and improved insect pest suppression strategies, including improvements in pesticide effectiveness, for population management approaches to improve crop production efficiency. Exotic organisms are received and cleared through the Stoneville Research Quarantine Facility for biological control of insects and weeds. Exotic predators and parasites are released and evaluated for establishment on field crop insect pests.

ARS PERSONNEL:

D. D. Hardee, Laboratory Director
T. G. Burton, Secretary OA
L. E. Taylor, Office Automation Assistant
W. W. Bryan, Quarantine Officer (on University leave)
F. M. Williams, Acting Quarantine Officer
G. G. Hartley, Entomologist (Insect Rearing)
H. E. Winters, Biological Technician (Insect Rearing)
R. L. Ford, Insect Production Worker
G. J. Patterson, Insect Production Worker
J. D. Warren, Engineering Technician (Shop)

SOUTHERN INSECT MANAGEMENT RESEARCH UNIT

Mission:

To develop new knowledge on the biology of field crop insects for development of new and improved control principles and to establish fundamental principles for encouraging and using natural enemies more effectively. To develop and integrate insect suppression strategies into field crop and pecan systems that minimize the cost of plant protection, yet are ecologically acceptable. Specifically:

1. Elucidate the efficacy of indigenous predators and parasites, particularly those attacking the bollworm, Helicoverpa zea, and tobacco budworm, Heliothis virescens.

2. Research and develop methods for augmenting parasite populations to management insect pests of field crops, particularly use of Microplitis croceipes and other parasitoids for control of Heliothis/Helicoverpa.

3. Develop new knowledge on biology and behavior of Heliothis/Helicoverpa spp., initially emphasizing genetic characterization of Helicoverpa for establishment of a bollworm sterile hybrid and utilization of the Heliothis sterile hybrid in area-wide management.

4. Conduct basic biological and ecological research on plant bugs, particularly the tarnished plant bug, Lygus lineolaris, and aphids, particularly the cotton aphid, Aphis gossypii.

5. Develop monitoring and predictive technology through quantitative population ecology for field crop insect pests, particularly bollworm/budworm, tarnished plant bug, and cotton aphid.

6. Assess the role of early season host plants in the buildup of Heliothis/Helicoverpa and tarnished plant bug populations and devise new and innovative tactics for suppressing these populations.

7. Develop chemical/biorational control tactics for use in integrated systems.

8. Develop chemical, biological, and other nonchemical methods for control of insect and mite pests of pecans. Evaluate selections and native pecans for yield and adaptability to the mid-south.

9. Locate, develop, and evaluate soybean cultivars resistant to insects.

ARS PERSONNEL:

D. D. Hardee, Research Leader, Laboratory Director
(Supervisory Research Entomologist)

M. R. Bell, Research Entomologist
R. W. Hoagland, Biological Technician

G. W. Elzen, Research Entomologist
L. C. Adams, Biological Technician

D. E. Hendricks, Research Entomologist
D. W. Hubbard, Biological Technician

L. Lambert, Research Entomologist
W. L. Solomon, Biological Technician

M. L. Laster, Research Entomologist
S. B. Ginn, Biological Technician
L. A. Cleveland, Biological Technician

W. P. Scott, Research Entomologist
D. A. Adams, Biological Technician

M. T. Smith, Research Entomologist
Vacancy, Biological Technician

G. L. Snodgrass, Research Entomologist
R. A. Drake, Biological Technician

P. G. Tillman, Research Entomologist
M. McQueen, Biological Technician

A. A. Weathersbee, Research Entomologist (Research Associate)

INSECT REARING RESEARCH UNIT:

Mission:

The goal of this management unit, located at Mississippi State, Mississippi, is to develop science and technology of mass propagation, storage, transfer, and release of cotton insects emphasizing the boll weevil, *Heliothis*, *Helicoverpa*, and the parasitoid, *Microplitis croceipes* (Cresson). Specifically:

1. Research is directed toward establishment of a cost effective propagation program capable of producing the quantity and quality of insects required to support field evaluation needs.

2. Initial research emphasis is placed on boll weevil production, automation of *Heliothis*/*Helicoverpa* and *Microplitis* rearing, establishment of quality control standards, establishment of standards for shipping and releasing insects, and evaluation of new rearing methods.

ARS PERSONNEL:

D. D. Hardee, Research Leader/Laboratory Director
(Supervisory Research Entomologist)

- J. L. Roberson, Supervisory Entomologist
  - T. L. Blair, Insect Production Worker
  - E. M. Griffin, Biological Technician
  - D. K. Harsh, Engineering Technician
  - O. L. Malone, Biological Laboratory Technician
  - G. G. McCain, Secretary
  - C. Tate, Insect Production Worker
  - M. Tate, Insect Production Worker

III. Summary of Research Progress for Calendar Year 1992

A. Narrative

1. In-House

Since the second year of the area-wide pilot test with Elcar against bollworms/budworms was cut short by severe weather in 1991, a smaller scale test was conducted in 1992. The objective was to determine the effectiveness of *Baculovirus heliothis* in reducing the emergence of tobacco budworm and cotton bollworm moths from early season hosts. The insect virus was applied aerially over a 6-mile diameter test area, and the effect on the first seasonal generation of *Heliothis*/*Helicoverpa* was evaluated. Compared to the 1990 test, the coverage was enhanced by using a "blanket" procedure of application. As in the previous test, persistence of the virus on the plant hosts as well as the effect on adult emergence was evaluated through bioassays, cage studies, and pheromone trapping inside and outside the test area. Results of the study indicated the probable use of this control method as an area-wide management tool for bollworm/budworm management in the Mississippi Delta; it also raised questions regarding early season movement of the first adult generation of budworms and bollworms. (M. R. Bell)

Laboratory bioassays of the baculovirus isolated from the celery looper demonstrated its potency against both budworms and bollworms and its possible use against these pests in the field. Tests to determine if the virus had effects on later stages of these hosts proved negative. (M. R. Bell)

The new baculovirus having a broad host range (celery looper isolate) was compared under field conditions through small plot studies to determine its effectiveness against tobacco budworms, cotton bollworms, beet armyworms, and cabbage and soybean loopers. Two field trials were set up, each with ten treatments and four replicates. One trial resulted in little data due to very low populations; however, the second test had very high populations. The relative infection rates of this virus were compared to two other baculoviruses. These field trials also indicated possible differences in effectiveness in the field due to the addition of an enhancer (blancophor). (M. R. Bell)

On-going laboratory bioassays of various viruses as well as new strains of the microbial insecticide, *Bacillus thuringiensis*, did not indicate any isolates of increased potency to cotton insects. (M. R. Bell)

Insecticides and biologicals were evaluated in small plots and in the laboratory using several bioassays. Registered, conjugated *B.t.*'s were more effective than natural *B.t.* proteins. (G. W. Elzen)

Increased resistance levels in tobacco budworm to endosulfan were not synergizable by pyrethroids. (G. W. Elzen)

The responses of an insecticide-resistant strain of Heliothis virescens were examined in the laboratory using two bioassays during continuous culture without insecticide selection pressure. Resistance to the pyrethroid, cypermethrin, and the carbamate, thiodicarb, did not revert to susceptibility until 12 generations in culture. The temporal sequence of resistance in field-collected H. virescens in 1992 was examined using the adult vial test and the spray table bioassay. Resistance to four classes of insecticides was variable but often at high levels prior to and during the cotton growing season. (G. W. Elzen)

The presence of metabolic resistance was detected using inhibitors of mixed function oxidases and hydrolytic esterases. Multifactorial resistance is present in field populations of tobacco budworm. (G. W. Elzen)

Six experiments (during 1990-92) studying sampling of aphids on cotton showed that numbers of aphids collected per method of sampling increase as the season progresses, from the top to the bottom of the plants. (D. D. Hardee, M. T. Smith, A. A. Weathersbee)

Treatment of greenhouse-grown cotton in pots with varying dosages of aldicarb controlled susceptible aphids more effectively than a colony resistant to various aphicides. More importantly, progeny of survivors from these treatments were 40-60% more tolerant of the same treatments than their parents. These findings are extremely important in the implication of continued, long-term usage of aldicarb, as well as in the possible use of sidedress applications of aldicarb following in-furrow application at planting. (D. D. Hardee)

Evaluations of Rapid Bioassay Kits from Rohm and Haas Company for testing insecticide resistance in cotton aphid showed that the method was reliable in differentiating tolerances of a resistant and susceptible colony of cotton aphids. (D. D. Hardee)

Comparison of the cotton cultivars, MD51ne, DES-119 and DPL-5415 in large fields planted by producers as well as small plots on the Delta Branch Experiment Station revealed that MD51ne (smoothleaf) and DPL-5415 (smoothleaf) had 40-60% fewer aphids than DES-119 (hairy leaf). No other insect counts were significantly different; yields will be compared later. (D. D. Hardee, A. A. Weathersbee)

Soybeans growing in plots of nectaried and nectariless cotton were equally infested with all soybean insects throughout the season. Numbers were extremely low for soybean looper, which was the target insect for evaluating influence of nectaried cotton on numbers. (D. D. Hardee, L. Lambert)

Major rearing advancements were gained by development of a hydraulic press to form cavities in parafilm sheeting used for production of Catolaccus grandis, an ectoparasite of boll weevil larvae. The equipment increased operational output capabilities of encapsulated boll weevils by approximately 4 times production rates and increased quality of the larvae encapsulated in sheeting. (D. K. Harsh, J. L. Roberson)

Insect production for USDA-ARS research in 1992 required maintenance of eleven insect species: Heliothis virescens, Helicoverpa zea, Heliothis virescens sterile hybrid, Anticarsia gemmatalis, Pseudoplusia includens, Spodoptera exigua, Galleria mellonella, Microplitis croceipes, Cardiochiles nigriceps, Microplitis demolitor, and Cotesia kazak. Research by USDA-ARS scientists at Stoneville and laboratories in Gainesville, FL; Tifton, GA; Mississippi State, MS; Fargo, ND; Weslaco, TX; College Station, TX; Phoenix, AZ; Beltsville, MD; Peoria, IL; Ithaca, NY; and Columbia, MO; required production of 604,800 H. virescens sterile BC pupae; 93,200 A. gemmatalis pupae; 1,023,400 H. virescens pupae; 257,600 S. exigua pupae; 313,000 P. includens pupae; 601,200 H. zea pupae; 26,000 G. mellonella larvae; 66,231 M. croceipes cocoons; 12,964 C. nigriceps cocoons; 8,068 M. demolitor cocoons, 8,301 C. kazak cocoons; 26,320,000 S. exigua eggs, 30,120,000 P. includens eggs, 53,680,000 H. zea eggs, 14,640,000 A. gemmatalis eggs; 67,920,000 H. virescens eggs and 34,086,000 H. virescens sterile BC eggs. Additional research support included sexing 420,000 H. virescens and H. virescens sterile BC pupae over a seven-week period in support of the sterile TBW-BC pilot test; mixing, dispensing and filling 107,010 30-ml plastic cups and 776 3.8-liter multicellular trays with artificial diet. Total diet mixed and dispensed in 1992 was 24,392 liters. Also, assistance was given to several scientists in maintaining insecticide-resistant strains of H. virescens and P. includens. (G. G. Hartley)

Participation in the American Soybean Association's Insect Distribution Program continues to grow with seventy-six researchers located in 21 states, Canada and England requesting insects. Participants were supplied with 998,000 eggs and 23,050 pupae of the bollworm, soybean looper, velvetbean caterpillar, beet armyworm, and Microplitis croceipes. Income realized after 10% administrative costs were deducted was used to purchase supplies. This program is expected to continue its growth in 1993. (G. G. Hartley)

The east and west sections of Building #9 (trailer complex) have been renovated. The west section was used to rear reproductive colonies of the sterile H. virescens BC and the east side was used to hold developing larvae shipped from the Gast Laboratory at Mississippi State, MS. Building #9 will be used again in the spring of 1993 for the second year's production of the TBW sterile hybrid BC Pilot Test. (G. G. Hartley)

The preference of Heliothis/Helicoverpa spp. for host plants and their dependency on wild plant hosts that serve as reservoirs for winter and early-season populations were studied. Season-long studies of the preference of Heliothinae spp. for either cultivated cotton or velvetleaf (Abutilon theophrasti) in relation to crop phenology and weather in 1992 clearly showed that velvetleaf is a plant host of major importance that supports these species. Velvetleaf was used by female moths of both species for oviposition in June of 1992 as in 1991. In the presence of blooming cultivated cotton plants, velvetleaf was equally attractive to ovipositing moths and was significantly attractive to ovipositing females before and after the cotton season. (D. E. Hendricks)

Techniques were developed and methods optimized for sampling and detecting insect populations in field conditions, and for monitoring their behavior and seasonal densities including meso- and micro-dispersal habits of tobacco budworm, bollworm, and fall armyworm. Surveys of Heliothinae spp. moth populations using replicated installations of 30-in. diam. pheromone traps baited with appropriate pheromone baits showed that moth catches from clusters of 3 to 4 traps set 50 ft apart at one location represented true population fluctuations more accurately than did installations of single traps. Inverted-cone pheromone traps 30-in in diam. caught about 3 times more bollworms and 2.6 times more budworm moths than did traps 24-in. in diam of a similar design. Clusters of 30-in diam. traps captured significant numbers of marked-released H. virescens-subflexa hybrid moths at distances from their release points that exceeded 6 miles. Correlation of weather conditions with population profiles during the growing season indicated that severe winter or springtime freezing or flooding may delay or prevent early buildup of larval populations during the cotton-growing season to below economically important levels. (D. E. Hendricks)

Studies of survival mechanisms associated with the bollworm and tobacco budworm pupation process showed that pupal mortality was correlated with the soil environment in typical agronomic conditions. Population density profiles plotted for the cotton crop season showed a slightly earlier and significantly larger buildup of tobacco budworms on cotton in 1992 than in 1991. Flooded soil conditions in 1991 increased the mortality rate of overwintering budworm pupae, but no

significant flooding occurred in the spring of 1992. Therefore, overall populations of tobacco budworms caused more damage in 1992 and resulted in greater pesticide application expenses. Population survey data from both trap captures and visual plant inspection were provided to Dr. Jeff Willers, ARS, Miss. State, to help substantiate the validity of computerized population prediction models now under development. (D. E. Hendricks)

Research continued to determine the origin of dispersing Heliothis/Helicoverpa spp. populations by genetic characterization of DNA and isoenzyme loci found in unique populations throughout the southern U.S. Bollworm and tobacco budworm moths caught in pheromone traps were contributed as part of a nationwide cooperative project to determine the origin of dispersing moths by genetic-DNA fingerprinting. This study involves 28 cooperative entomologists collecting moths at standardized "time windows" throughout the year. This study was coordinated here and chemical analyses are being done by Karl Narang, ARS Fargo, ND. This study might also identify moths that migrate or otherwise disperse from one crop area to another on a meso-scale. Similar cooperative studies in cooperation with Amy Korman, Miss. State, indicated that tobacco budworm populations separated by 85 km might be genetically different. (D. E. Hendricks, K. Narang, A. Korman and many State and ARS entomologists)

Formulations were developed for bioactive materials including attractants, disruptants, or attracticides affecting mortality or the behavior of insect pests of cotton and other agronomic or wild host plants. Lures for use in 30-in. diam. traps for monitoring tobacco budworm and (H. virescens x H. subflexa) BC moths were formulated and produced for use during the current growing season. These lures contained a 3-component pheromonal blend which is not yet readily available from all commercial sources. Technical information about formulation techniques of producing these 3-component baits was conveyed to Hercon and Scentry. Technical information about the superior performance of these 3-component lures was provided to several other chemical firms and to 8 agricultural consultant firms. (D. E. Hendricks)

The adult vial test (AVT) was evaluated for its utility in predicting resistance levels in tobacco budworm to non-pyrethroid insecticides and in predicting resistance to OP's and pyrethroids in the boll weevil. Field strains collected throughout the season in Washington County, Miss., were used to establish baseline discriminating doses for the AVT. (L. Kanga, B. Plapp, G. W. Elzen)

Evaluation of twelve insect resistant soybean genotypes with different maturity dates was continued for a third year to determine if resistance levels change during plant maturation. The studies were conducted in a large field cage utilizing laboratory-reared insects. It was found that all genotypes had essentially the same level of resistance prior to fruiting. After the onset of fruiting the later maturing genotypes exhibited a higher level of resistance than earlier maturing genotypes. Additional studies will be required to determine if resistance levels decrease during the fruiting phase or if later maturing genotypes develop higher levels of resistance. (L. Lambert)

In field cage evaluations of 1200 accessions from the USDA-ARS soybean germplasm collection, several genotypes were identified with high levels of resistance to foliar feeding by soybean looper. Evaluations with velvetbean caterpillar did not identify genotypes resistant to this species. These accessions will be further evaluated and used in a breeding effort to develop soybean cultivars with high levels of resistance to insects. (L. Lambert, T. C. Kilen)

A study was continued for a second year with soybean looper to determine if genetic removal of pubescence from soybean, which reduces oviposition, coupled with foliar feeding resistance would result in a decrease in level of damage. Isolines of 'Davis', 'Tracy-M', and insect resistant line D75-1069, with dense, normal, and no pubescence were evaluated in a large field cage using laboratory-reared insects. Oviposition levels were lower on all isolines without pubescence than on ones with pubescence. Defoliation levels of the pubescence isolines were greater than that of the no-pubescence isolines. This indicates that an additional level of resistance may be achieved in soybean genotypes resistant to foliar feeding insects by genetically removing plant pubescence. (L. Lambert, T. C. Kilen)

Studies were continued for a third year in small field cages with several cotton genotypes to determine the influence of nectar and plant pubescence on oviposition levels of tobacco budworm. For the second year, plants without nectaries and without pubescence received the same number of tobacco budworm eggs as plants with pubescence and with nectaries. These results indicate that under the conditions of our study, the genetic removal of plant nectaries and pubescence may not reduce naturally occurring tobacco budworm populations in cotton fields. (L. Lambert, W. R. Meredith)

Studies confirmed for a second year in small field cages that the celery looper virus completely controlled the second generation of soybean loopers. (L. Lambert, W. L. Solomon, M. R. Bell)

A study with soybean isolines of normal, dense and glabrous types to determine the influence of pubescence on the effectiveness of B.t. in controlling soybean looper showed that B.t. was most effective on glabrous types. (L. Lambert, J. E. Mulrooney)

The initial release in a pilot test to suppress the tobacco budworm with sterile backcross (BC) releases was conducted in a 10-mile square area near Stoneville, Mississippi. Releasing 68,600 BC moths per day from 25 release points from April 2 to May 15, resulted in a 3.0:1.0 released:wild ratio. Continued sterility monitoring of trap captures showed that wild moths moving into the release area dropped the sterile:fertile ratio from 3.0:1.0 during the release to 1.3:1.0 during the June population and 1.0:2.3 during the July population. Although the released:wild ratio of moths was low, the number of wild moths trapped in the release area in June was lower than the number trapped in the control area 17 miles away. Released moths were captured in the most distant trap which was 25 miles from the nearest release point. Identification of larvae and adult moths from field-collected eggs and larvae showed that field populations in the release area were 69% Heliothis virescens and 31% Helicoverpa zea. Similar collections in the control area showed that field populations were 78% H. virescens and 22% H. zea. Emergence of released insects was slowed by low temperatures during the early part of the release period. Consequently, some pupae had not emerged after two weeks in the field. Corrective measures to enhance emergence during the 1993 release will be to hold the pupae until initiation of emergence before placing them in the field and allow them to remain in the field 16 days to complete emergence. (M. L. Laster, D. D. Hardee)

Research on the tobacco budworm sterile backcross has continued with maintenance of two advanced backcross colonies, currently in the 207th and 75th generations. The 75th generation colony will be increased for the pilot release program in 1993. (M. L. Laster)

A search for hybrid sterility in Helicoverpa zea was continued with the completion of crossing studies of H. zea with H. armigera imported from the former Soviet Union. No sterility was detected in these crosses that could be used to suppress H. zea in a wide-area release program. (M. L. Laster, D. D. Hardee)

Wax-coated cardboard boxes were found to be reliable for dual purpose use as rearing containers and field release stations for Microplitis croceipes. (O. L. Malone, J. L. Roberson)

Topical bioassays of cypermethrin, endosulfan, methomyl, profenofos, and sulprofos were conducted on colonies from Louisiana, Mississippi, and Texas. The field-collected colonies exhibited low to high levels of resistance to cypermethrin (1-42x), low to moderate levels of resistance to

profenofos and sulprofos (1-6x), and low to high levels of resistance to methomyl (2-21x). Spray chamber bioassays indicated reduced efficacy of cypermethrin, endosulfan, profenofos, and thiodicarb against the field-collected colonies of tobacco budworms. (S. H. Martin, G. W. Elzen, J. B. Graves)

The Insect Rearing Research Unit (IRRU) maintained colonies of Anthonomus grandis grandis, Heliothis virescens, Helicoverpa zea and Microplitis croceipes for service support and mass rearing research. Mass rearing programs were conducted in support of H. virescens backcross pupae and Catolaccus grandis boll weevil parasites. The mechanized insect production system maintained stable output of 25,000 trays per week (700,000 pupae) for a six-week period of 4.2 million pupae in support of the H. virescens backcross program. The rearing program maintained record production levels of 160,000 Heliothis pupae per day and presents evidence that rearing technologies are established to provide stable laboratory production, an essential element of biological control programs. Production output of encapsulated boll weevil larvae exceeded program plans by 4 times production rates to provide excess parasites requested for field release tests. It is estimated that approximately 1 million boll weevil larvae were encapsulated and shipped to ARS in Weslaco, Texas, in support of the Catolaccus grandis research projects. In addition, approximately 2.5 million boll weevils were provided to Cotton Foundation recipients and local ARS and MAFES research scientists. (J. L. Roberson)

Rearing equipment (oviposition room, cages, egg washer) to enable production of 700,000 Heliothis virescens backcross pupae per week was constructed and tested prior to initiation of insect production in March 1992. (J. L. Roberson, D. K. Harsh)

Modification of clean-up procedures for flash sterilizing equipment enabled extended use periods for diet processing. (J. L. Roberson, M. Tate)

Narrow row (30") and normal row spacings (40") of cotton were evaluated in 1992 to determine insect pest populations, yield, and maturity. Two 90-acre fields were selected for the study and were approximately one half mile apart. The fields were under different management but were of the same soil type. The variety, planting date, fertilization, and herbicide program were the same. Early-season treatments in both plantings included Temik (0.50 lb AI/acre) and Cygon (0.20 lb AI/acre). Each treatment was replicated six times. Both fields received the same in-season insecticide treatments to control economic pest populations. The 40" cotton received two (2 oz) applications of PIX and the 30" cotton received six applications of PIX or a total of 22 oz. There were no

differences in yield or maturity in the two row spacings. The Temik-treated cotton had higher yields than cotton treated with Cygon for control of early season pests. A higher infestation of bollworms was present in the 30" cotton in late July. (W. P. Scott)

Plant bugs were sampled in 30-in and 40-inch row spacings throughout the season. There were no differences in populations which was probably due to frequent sprayings for bollworm control. (W. P. Scott, G. L. Snodgrass)

Economic studies of growing narrow row cotton will be available to agricultural economists yearly but will not be analyzed until after 3 years of research. (W. P. Scott, F. T. Cooke)

Spray table and small field plots were used to evaluate new chemistry which has shown good activity on various cotton pests. Due to secrecy agreement, results are not available. (W. P. Scott)

Under heavy bollworm pressure, there was no difference in level of control or yield with the different pyrethroid insecticides when used at comparative rates. A large field plot experiment was conducted to compare bollworm control of deltamethrin with that of cyhalothrin and cyfluthrin. In 1992, Rhone Poulenc was granted a EUP to test deltamethrin in the U.S. (W. P. Scott)

The pecan aphid complex is composed of three aphid species: the blackmargined aphid, Monellia caryella (Fitch), the yellow pecan aphid, Monelliopsis pecanis Bissell, and the black pecan aphid, Melanocallis caryaefoliae (Davis). Investigations of host plant resistance, host plant specificity and host plant selection of these three aphid species were conducted at several plant phylogenetic levels. Closely related tree species of pecan within the Juglandaceae family of nut trees of North America were evaluated in regard to their suitability as hosts for M. caryella, M. pecanis and M. caryaefoliae. Nymphal survival and developmental rate and adult survival and reproductive rate were studied on all thirteen hickory (Carya) species, one hybrid species (hican) and two walnut (Juglans) species. Those species of the Juglandaceae most closely related phylogenetically to pecan were shown to be the most suitable host plants of each aphid species and life stage. M. caryaefoliae was found to have the widest host range, while M. caryella the most restricted host range among the three aphid species. In addition, these studies incorporated the evaluation of host specificity as a function of seasonal changes in host plant phenological stages of development. Most significant was the finding that host specificity and/or suitability is strongly influenced by the seasonal changes in plant development. Moreover, these results were obtained

independent of environmental fluctuations. Data from behavioral studies of host plant preference have not as yet been analyzed. (M. T. Smith, B. W. Wood, W. L. Tedders, C. C. Reilly)

Field validation of the above described laboratory studies was performed for all three aphid species among the Juglandaceae species. Data collected have not as yet been completely analyzed. However, the results appear to reflect closely the results found in our laboratory studies. (M. T. Smith, W. L. Tedders, B. W. Wood)

Pecan cultivars were evaluated in regard to their suitability as hosts for M. caryella, M. pecanis and M. caryaefoliae. Pecan cultivars evaluated were selected from across a spectrum of cultivars reported and/or suspected to show varying degrees of resistance to pecan aphids, as well as plant pathogens. The ten cultivars included Pawnee (reported to be resistant), Desirable, Schley, Wichita, Cape Fear, Kiowa, Sumner, Western Schley, Stuart and Cheyenne (reported to very susceptible). Nymphal survival and developmental rate and adult survival and reproductive rate were monitored as a function of cultivar and seasonal changes in host plant phenological stages of development. Data from these studies have not as yet been analyzed. (M. T. Smith, R. C. Reilly)

In order to understand the mechanisms of resistance associated with the above mentioned studies, both foliar chemistry and morphology are being investigated. Comparative foliar plant chemical analysis of the Juglandaceae species and the pecan cultivars was performed. Both foliar cuticular and internal chemistries were extracted and are currently being analyzed by GC, GC-MS, and HPLC procedures. (M. T. Smith, R. C. Gueldner, R. F. Severson, I. Yates)

Additionally, the surface structure of the Juglandaceae species is being investigated via SEM. (M. T. Smith, R. Paul)

Investigations were conducted on the utility of Temik as an aphicide in two types of reduced-input, biological control pecan pest management systems. In one instance the orchard floor is intensively managed via conventional mowing, while in the other instance, insectary plants which harbor beneficial insect species are planted on the orchard floor. Data from these studies have not as yet been analyzed. (M. T. Smith, B. Layton, T. Jenkins)

Investigations were planned and conducted to determine the utility of trap crops (sequentially attractive) designed to intercept migrating insect pest species as they move from soybean to pecan. (M. T. Smith, G. L. Snodgrass)

Research was initiated on the re-evaluation of the hickory shuckworm sex pheromone. To date, one, possibly two, additional EAD responses have been discovered which are not accounted for by any known sex pheromone compound of the hickory shuckworm. Identification of these compounds is in progress and field bioassays are planned for the spring moth flight in 1993. (M. T. Smith, G. Greis, M. Hall)

As part of a 3-year study designed to develop a season long sampling system for the cotton aphid (*Aphis gossypii* Glover), aphid density within the canopy of a cotton plant was measured at: (1) the 4th fully expanded leaf from the terminal; (2) the 1st main stem leaf one-third distance down from the terminal; and (3) the 1st main stem green leaf above the 1st fruiting branch from the ground (see Hardee, this report). Although the data have not yet been analyzed, it appears that aphid density varied within the canopy of a cotton plant. Furthermore, varying aphid density within the plant canopy changed with the phenological stage of cotton plant development. Therefore, it appears that any season-long sampling scheme utilized for *A. gossypii*, where the experimental unit is less than the entire plant, must consider within plant canopy variation (i.e. leaf location) and phenological developmental stage of the plant. (M. T. Smith, D. D. Hardee, A. A. Weathersbee)

Fungicides were applied at planting for the second year and were evaluated with respect to their potential effects upon the incidence and prevalence of the entomopathogenic fungus *Neozygites fresenii*, a natural controlling agent of *A. gossypii*. Given the significant variation in aphid density within the plant canopy and across the phenological stages of plant development, sampling incorporated the system utilized in the above mentioned study via taking samples at the three plant canopy locations. Data from these studies have not as yet been analyzed. (M. T. Smith, D. D. Hardee)

Factors governing the seasonal dynamics of *A. gossypii* were investigated for the second year. Among the biotic factors monitored was the entomopathogenic fungus, *Neozygites fresenii*, a natural controlling agent of *A. gossypii*, and *Lysiphlebus testaceipes*. Abiotic factors monitored included leaf wetness and air temperature, each recorded at the three locations within the plant canopy. In addition, soil moisture, air temperature and relative humidity above the plant canopy, as well as rainfall were also monitored. Data from this study have not as yet been analyzed. (M. T. Smith, D. D. Hardee)

Preliminary investigations of imported parasitoids of the sweetpotato whitefly (SPWF) were initiated. This sweetpotato whitefly:parasitoid:host plant interactions research is designed to determine the biological and behavioral performance of selected parasitoid species under different

whitefly and host plant scenarios. Scenarios investigated are based upon those situations where the SPWF has caused severe or total crop losses in Arizona, the Imperial Valley in southern California, the Rio Grande Valley in Texas and in Florida. (M. T. Smith, F. M. Williams, L. V. Knutson, F. Herard)

The braconid wasp, Peristenus digoneutis Loan, was released into an alfalfa field infested with tarnished plant bugs located in the edge of the Mississippi Delta near Holcomb, MS. Releases (males + females) were made on 29 May (30 + 70), 22 July (78 + 42), 26 July (32 + 17), 2 August (66 + 31), and 12 August (40 + 40). The adult parasites were obtained from Bill Day, Beneficial Insects Research Laboratory, USDA-ARS, Newark, DE. A large population of tarnished plant bug nymphs (which P. digoneutis attacks) was present in the alfalfa field in May and June, averaging 49 nymphs per ten sweeps in May and 24 per ten sweeps in June. During July and August this population declined to 12 and 5 nymphs per 10 sweeps, respectively. Since the objective was to establish the parasite in Mississippi, the field was not intensively sampled to determine if plant bug nymphs were parasitized for fear of harming any developing parasite population. It will be determined if establishment has occurred by sampling the field in the spring and summer of 1993. (G. L. Snodgrass)

The within-plant distribution of the tarnished plant bug in cotton was studied at Stoneville, MS, in June-August. Distributions of adults and nymphs were determined from a cotton field having a natural infestation using visual observations and 4 observers. Distributions were determined in the morning and again in the afternoon at weekly intervals. Nymphs were found during the entire test mainly on squares (72.1% of all nymphs observed), while adults were found mainly on leaves (57.6 - 71.4% of all observed) through the third week of square production. Adults then became fairly evenly distributed on leaves, fruit, and mainstem terminals during the remainder of the study. There were no differences in the distribution of adults or nymphs found in the morning and in the afternoon. These distributions help explain why different sampling methods work better for nymphs and adults. (G. L. Snodgrass)

A study on the efficiency of the sweep net for tarnished plant bug adults in cotton was again conducted (as in 1991) using adults marked for individual identification (using Testors paint) and released into cotton enclosed in 24 X 12 X 6 ft field cages. Adults were located on plants, individually identified, then sampled with a standard (15-in diam.) sweep net each week over a 6-week period. The location of each adult on the plant along, with whether or not it was captured, was recorded along with the side of the plant (in relation to the adult) from which the sweep was made. Average plant characteristics including height, number of mainstem nodes, and location of squares, blooms, and bolls were also

recorded. Using these data, along with data from the previous year, capture efficiency can be calculated for adults at various plant positions in time as the plants grow. This information will be used along with data on the distribution of adults within cotton plants (see previous paragraph) to try and develop a predictive equation for the efficiency of the sweep net for adults as the plant grows during the season. (G. L. Snodgrass)

There was no preference for Heliothis virescens and H. virescens-H. subflexa hybrid by Microplitis croceipes in the laboratory. Also, there was no significant difference in parasitization of these two hosts by this parasitoid in large field cages. (P. G. Tillman)

A curvilinear functional response occurred for both M. croceipes and Cardiochiles nigriceps in large field cages. The mean number of H. virescens parasitized per female per day was determined to be 6.09 and 4.55 for C. nigriceps and M. croceipes, respectively. (P. G. Tillman)

Female density of M. croceipes and C. nigriceps effected parasitization of H. virescens. Significant differences in parasitization occurred between densities of 0.037 females/m^2 and 0.075 females/m^2. However, a significant difference in parasitization did not occur between densities of 0.075 females/m^2 and 0.149 females/m^2. In other words, doubling the density of females from 0.075 to 0.149 females/m^2 in a cage (26.8 m^2) did not increase parasitization. Increasing the density of females simply increased superparasitism. (P. G. Tillman)

Parasitization of H. virescens by M. croceipes and C. nigriceps and of Anthonomus grandis by Catolaccus grandis was significantly lower at field temperatures ranging in the 70's than temperatures in the 80's and 90's. (P. G. Tillman)

C. grandis will parasitize boll weevils only on plants when given a choice of hosts on the ground and on the plant. However, this parasitoid will parasitize boll weevils on the ground when given no other choice. Even then parasitization is lower on these ground hosts than on hosts on the plant. This parasitoid must prefer searching the plant for hosts. A linear functional response was determined for this parasitoid on boll weevils in large field cages. (P. G. Tillman)

A field-plot screening test was conducted to evaluate 24 cotton genotypes for reduced susceptibilty to cotton aphid, Aphis gossypii Glover. Significant differences were detected in aphid densities among cotton lines on 6 of 10 sampling dates even though aphid populations were low due to insecticide treatments for other pests. Insecticide applications reduced differences among aphid populations; however, distinctions recurred several days after each

treatment. Selected cotton lines differed by nearly 3-fold at peak aphid density while maximum differences detected late in the season were greater than 20-fold. Average aphid densities for the entire season significantly differed by greater than 2-fold among some genotypes. All cotton lines were partitioned into 7 cluster groups by Ward's Minimum Variance Cluster Analysis which accounted for 70% of the variability in aphid density. Two very promising cotton lines were detected in the cluster having the lowest aphid density while a widely used commercial cultivar was classified alone in a cluster having the highest density. Analysis of variance and cluster analysis indicated that lower aphid densities were found on smoothleaf cotton lines. (A. A. Weathersbee III, D. D. Hardee, W. R. Meredith)

Seasonal dynamics of the cotton aphid and its parasite, pathogen, and predator complex were monitored throughout the period of aphid abundance on six cotton cultivars (DP90, MD51ne, DP50, ST453, DES119 and ST825). The order of magnitude for aphid density among cultivars, given above in ascending order, was established early and remained mostly stable. Aphid density differed significantly among cultivars on 13 of 18 sampling dates. There was a 3-fold difference in the range of aphid counts among cultivars at peak aphid density. Lower aphid densities were observed on cultivars with smooth leaves. Average counts for the entire season were lowest on DP90 and MD51ne (smooth) and highest on DES119 and ST825 (hairy), with a greater than 2-fold significant difference in the range of means. No significant differences were detected in the levels of aphid parasitism by the wasp, _Lysiphlebus_ _testaceipes_ Cresson, among cotton cultivars. The lack of difference may be attributed to reduced parasite searching efficiency on hairy cottons and/or competition by the entomopathogenic fungus, _Neozygites_ _fresenii_ Batko. Parasitism levels were maximized at time of peak aphid density and ranged from 46-61% among aphid populations from different cultivars. _N_. _fresenii_ infection levels were highest 1 week after peak aphid density and ranged from 49-71% among aphid populations from different cultivars. Significant differences were observed in entomopathogen infection levels at this time. The observed differences likely were due to the density-dependent nature of the fungal epizootic, since the order of magnitude for pathogen infection was identical to that for aphid density among cultivars. Temperature and humidity monitored bi-weekly within the plant canopy showed that differences among cultivars were not apparent. Significant differences were detected in the abundance of some aphid predators among cultivars; but as with the pathogen, predator density often was correlated with aphid density. Numbers of Coccinellids and _Orius_ spp. were highest immediately after peak aphid density and then declined. Several other known aphid predators continued to increase after peak aphid density, regardless of the fungal epizootic and resulting low aphid populations. These included the

hemipteran predators, Deraeocoris nebulosis and Geocoris punctipes, which likely were better adapted to switch to other prey species when aphid density declined. The study indicated that reduced cotton aphid susceptibility is present among commercially available cotton cultivars and those being developed. The parasitic wasp, L. testaceipes, was an efficient early-season, control agent but its effectiveness in this study may have been enhanced by the absence of insecticides. The entomopathogenic fungus, N. fresenii, was the most effective biological control agent with respect to the proportion of aphids affected and the duration of activity. (A. A. Weathersbee III, D. D. Hardee)

A laboratory study was conducted to collect life-table statistics for the cotton aphid on 6 cotton cultivars. The study was conducted twice on excised cotton leaves in petri dishes (12 cohorts each) and once on live plants with aphids confined by clip cages (6 cohorts). Individual aphids were monitored from birth to death. Estimates of longevity, fecundity, and pre-reproductive periods were obtained. Data analysis has not been completed but there appear to be differences in aphid population growth potential among cotton cultivars. (A. A. Weathersbee III, D. D. Hardee)

A study was undertaken to evaluate the effect of host age on developmental time of the entomopathogenic fungus, N. fresenii. Time from exposure to infective conidia until death caused by the pathogen was monitored in cotton aphids 1-5 days old. Initial data indicate a tendency for accelerated activity against younger aphids at 25°C and humidity near saturation. The study will be further replicated before definitive conclusions are made. (A. A. Weathersbee III, D. D. Hardee)

The Stoneville Research Quarantine Facility (SRQF) received eight shipments of exotic insect material in 1992. Shipments were received from India, Egypt, Spain, Pakistan, Nepal, and Indonesia. Seven of the shipments were imported in support of research on sweetpotato whitefly, Bemisia tabaci (Gennadius). The shipments included several species of pupal parasitoids in the genera Encarsia and Eretmocerus, including Encarsia lutea (Masi) and Encarsia transvena (Timberlake). Colonized species have either been shipped to cooperators or located in the SRQF. Currently in colony are Encarsia formosa, E. transvena, and Eretmocerus mundus. The Indonesian shipment was received in support of the Helicoverpa zea sterile hybrid project. The Helicoverpa sp. shipment was used for crossing trials with H. zea. There were fifty shipments released to cooperators from the SRQF in 1992. (F. M. Williams)

2. Extramural

Studies conducted by P. P. Sikorowski through Cooperative Agreement (ARS-MAFES) identified presence of nonoccluded baculovirus within the egg of *Microplitis croceipes*. The presence of the virus was detected using an electron microscope. The study focused on development of both direct and indirect ELISA methods to determine infection of virus in the *M. croceipes* laboratory colony. (P. P. Sikorowski, J. L. Roberson)

B. Indicators of Progress

1. Publications (Published, In Press, Accepted)

Bell, M. R., D. D. Hardee, J. L. Hayes, and E. A. Stadelbacher. 1992. Management of cotton bollworm/tobacco budworm populations through area-wide application of nuclear polyhedrosis virus on early-season alternate hosts, pp. 24-37. In Cotton Integrated Pest Management: Proc. Symposium, September 3-9, 1990, Tashkent, Uzbekistan. USDA-ARS, ARS-106.

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Smith, M. T., and D. D. Hardee. Influence of granular fungicides applied at planting on seasonal development of the entomopathogenic fungus Neozygites fresenii (Nowakowski) Batko in the cotton aphid (Aphis gossypii Glover). (In Preparation).

Smith, M. T., R. F. Severson, G. W. Chapman, and R. J. Horvat. Volatiles of the leaflet, rachis and nut of pecan, Carya illinoensis: Potential role in habitat and host finding of pecan herbivore and beneficial insect species. (In Preparation).

Smith, M. T., and B. W. Wood. Developmental and reproductive performance of the blackmargined aphid, Monellia caryella Fitch, the yellow pecan aphid, Monelliopsis pecanis Bissell, and the black pecan aphid, Melanocallis caryaefoliae (Davis) on the North American species of the Juglandaceae: A study of aphid-plant coevolution. (In Preparation).

Smith, M. T., R. F. Severson, and B. W. Wood. Host-plant selection by the blackmargined aphid, Monellia caryella Fitch, the yellow pecan aphid, Monelliopsis pecanis Bissell, and the black pecan aphid, Melanocallis caryaefoliae (Davis) on the North American species of the Juglandaceae: A comparative study of foliar cuticular chemistry and host-plant recognition. (In Preparation).

Smith, M. T., T. M. Perring, B. W. Wood, and W. L. Tedders. Electronic feeding monitor analysis of the feeding behavior of the blackmargined aphid, Monellia caryella Fitch, on the North American species of the Juglandaceae. (In Preparation).

Smith, M. T., and B. W. Wood. Alternative methods for controlling pecan aphids. (In Preparation).

Snodgrass, G. L. Estimating absolute density of nymphs of Lygus lineolaris (Heteroptera: Miridae) in cotton using drop cloth and sweep net sampling methods. J. Econ. Entomol. (Submitted 7/28/92).

Snodgrass, G. L. Distribution of the tarnished plant bug within cotton plants. Proc. Beltwide Cotton Prod. Conf. (In peer review).

Snodgrass, G. L. and E. A. Stadelbacher. Effect of various early-season treatments for control of tobacco budworms and bollworms in wild geranium on tarnished plant bug populations. (In preparation).

Tillman, P. G. Comparison of parasitization of Heliothis virescens and H. virescens-H. subflexa hybrid by Microplitis croceipes. (In Preparation).

Tillman, P. G. Comparison of functional response of Microplitis croceipes and Cardiochiles nigriceps. (In Preparation).

Tillman, P. G. Effect of female density on parasitization of Heliothis virescens by Microplitis croceipes and Cardiochiles nigriceps. (In Preparation).

Tillman, P. G. Effect of field temperatures on parasitization of Heliothis virescens by Microplitis croceipes and Cardiochiles nigriceps and of Anthonomus grandis by Catolaccus grandis. (In Preparation).

Tillman, P. G. Searching behavior of Catolaccus grandis for boll weevils on the ground versus on the plant. (In Preparation).

Tillman, P. G., M. L. Laster, and J. E. Powell. 1993. Development of the endoparasitoids Microplitis croceipes, Microplitis demolitor, and Cotesia kazak (Hymenoptera: Braconidae) on Heliothis zea and Heliothis armigera (Lepidoptera: Noctuidae). For J. Econ. Entomol. (In Preparation).

Weathersbee, A. A., and D. D. Hardee. Indices of relative abundance of the cotton aphid, Aphis gossypii Glover, and associated parasites, pathogens, and predators on six cotton cultivars. (In Preparation).

Weathersbee III, A. A., and D. D. Hardee. Seasonal dynamics of cotton aphid, Aphis gossypii Glover, and its parasite, pathogen and predator complex on six cotton cultivars. (In Preparation).

Weathersbee III, A. A., D. D. Hardee, and W. R. Meredith. Comparisons of cotton aphid, Aphis gossypii Glover, seasonal abundance among 24 cotton genotypes. (In Preparation).

Weathersbee III, A. A., and D. D. Hardee. Cotton aphid, Aphis gossypii Glover, life-table statistics generated from aphid confinement to six different cotton cultivars. (In Preparation).

Womac, A. R., J. E. Mulrooney, W. P. Scott, and J. R. Williford. Influence of oil droplet size on transfer of bifenthrin from cotton to tobacco budworm. For Pesticide Science. (In Preparation).

Wood, B. W., J. A. Payne, and M. T. Smith. Foliar sprays of potassium nitrate and surfactant suppress orchard populations of pecan aphids. (In Review)

3. Presentations

Bell, M. R. "NPV uses in crop protection." Zoecon Research Institute for Sandoz Crop Protection Laboratory, Palo Alto, CA, January 1992. (Invitation).

Bell, M. R. "Development of entomopathogens for insect pest control." Southern Regional Project S-240, Orlando, FL, February 1992.

Bell, M. R. "Management of bollworm and tobacco budworm by large area applications of entomopathogenic viruses." Southeastern Branch Meeting of ESA, Savannah, GA, March 1992.

Bell, M. R. "Advances in the use and mass production of baculoviruses in insect pest management." Combined meeting of DuPont and Crops Genetic International personnel, Hanover, MD, May 1992. (Invitation).

Bell, M. R. "Management of budworm/bollworm populations by early season application of nuclear polyhedrosis virus - a progress report." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992.

Elzen, G. W., S. Martin, R. Leonard, and J. Graves. "Inheritance, stability, and reversion of insecticide resistance in tobacco budworm (Lepidoptera: Noctuidae) populations." Beltwide Cotton Prod. Res. Conf., Nashville, TN, January 1992.

Elzen, G. W. "Larvin ovicide/larvicide results." Rhone-Poulenc Mid-South Cotton Seminar, Monroe, LA, January 1992.

Elzen, G. W. Participant, Pirate Insecticide-Miticide Workshop, American Cyanamid, New Orleans, LA, January 1992. (Invitation) (International Meeting)

Elzen, G. W. "Inheritance, stability, and reversion of insecticide resistance in tobacco budworms." Louisiana Agricultural Consultants Association, Pest Management Workshop, Alexandria, LA, February 1992.

Elzen, G. W. "1992 Insecticide Resistance Update." Ciba-Geigy Cotton Consultant Seminar, Perdido Beach, AL, February 1992.

Elzen, G. W. "Current status of insecticide resistance--why we need new approaches." Symposium, Southeastern Branch Meeting of ESA, Savannah, GA, March 1992.

Elzen, G. W. "Integration of chemical and biological methods in management programs." Global Management of Resistance in the 90's, Abbott Chemical, Lake Bluff, IL, September 1992.

Elzen, G. W. "Evaluation of Heliothis resistance levels, 1992." Curacron Workshop, CIBA-GEIGY, Memphis, TN, October 1992.

Elzen, G. W. "Status of insecticide resistance and mechanisms in tobacco budworm." Tri-State Tobacco Budworm IRM Meeting, Northeast Research Station, St. Joseph, LA, October 1992.

Elzen, G. W. "Status of Heliothis resistance in Mississippi." PEG-U.S., Baton Rouge, LA, October 1992.

Elzen, G. W. "Toxicological studies involving insecticide resistance in the tobacco budworm and soybean looper." Miss. Agricultural Consultants Entomological Training Workshop, Mississippi State, MS, November 1992.

Elzen, G. W. "Evaluation of Heliothis insecticide resistance levels, 1992." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992.

Hardee, D. D. "Working within regulatory constraints to achieve research objectives." Mid South Area Research Leaders' Meeting, Nashville, TN, March 1992. (Invitation)

Hardee, D. D. "Role of Location Coordinator." Mid South Area Research Leaders' Meeting, Nashville, TN, March 1992. (Invitation)

Hardee, D. D. "Cotton insect research review." Annual Meeting, Delta Council Advisory Research Committee, Stoneville, MS, September 1992. (Invitation)

Hardee, D. D. "Insecticide control and resistance in cotton aphid." Sticky Cotton Symposium, 45th Annual Cotton Insect Insect Research and Control Conference, Nashville, TN, January 1992. (Invitation)

Hardee, D. D. "Large-scale program for management of Heliothis/Helicoverpa." Symposium, Southeastern Branch Meeting of ESA, Savannah, GA, March 1992.

Hardee, D. D., and R. E. Frisbie. "Cotton Commodity Report." National Integrated Pest Management Forum, Washington, D.C., June 1992. (Invitation)

Hendricks, D. E. "Preference of bollworms and tobacco budworms for velvetleaf vs. cotton as indicated by plant inspection and trapping." Beltwide Cotton Prod. Res. Conf., Nashville, TN, January 1992.

Hendricks, D. E. "Season-long preferences of bollworms, Helicoverpa zea, and tobacco budworms, Heliothis virescens, for velvetleaf vs. cotton in the Mississippi River delta." Southeastern Branch Meeting of ESA, Savannah, GA, March 1992.

Jenkins, T. and M. T. Smith. "Pecan management in the Mississippi Delta." Alabama Pecan Growers Association Meeting, Fairhope, AL, September 1992.

Lambert, Lavone. "Influences of drought stressed soybean on insect populations." Pest Management Workshop, Delta State University, Cleveland, MS, February 1992. (Invitation).

Lambert, Lavone. "Influences of water management on insect populations in soybean." Soybean Looper Workshop, Nashville, TN, April 1992. (Invitation).

Lambert, Lavone. "Assessment of soybean germplasm for multiple insect pest resistance." National ESA Annual Meeting, Symposium on Identification and Conservation of Insect Resistance Genes from Plant Germplasm, Baltimore, MD, December 1992. (Invitation).

Laster, M. L., and D. D. Hardee. "Emergence and distribution of Heliothis moths in the area-wide release program." Beltwide Cotton Prod. Res. Conf., Nashville, TN, January 1992.

Laster, M. L. "Sterile hybrid update." 18th Annual Delta Ag Expo, Cleveland, MS, January 1992.

Laster, M. L. "Genetic sterility." Symposium, Southeastern Branch Meeting of ESA, Savannah, GA, March 1992.

Laster, M. L. "Releasing genetically sterile insects to control the tobacco budworm." USDA-ARS Earth Day Forum, Stoneville, MS, April 1992.

Laster, M. L., D. D. Hardee, and J. C. Schneider. "An up-date on the pilot test to control the tobacco budworm by releasing sterile backcross insects." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992.

Laster, M. L. "Genetic sterility of the tobacco budworm." National ESA Annual Meeting, Baltimore, MD, December 1992.

Scott, W. P. "Temik performance in cotton." Rhone Poulenc Mid-South Cotton Seminar, Monroe, LA, January 1992.

Scott, W. P. "Early season insect control in cotton." Cotton Seminar, West Tennessee Exp. Station, Jackson, TN, February 1992.

Scott, W. P. "Five-year summary of Temik performance in cotton." Rhone Poulenc Southwest Cotton Seminar, San Antonio, TX, February 1992.

Scott, W. P. "Five-year summary of Temik performance in cotton." Rhone Poulenc Southeast Cotton Seminar, Raleigh, NC, March 1992.

Scott, W. P. "Safe use and economic value of Temik." Pesticide Overexposure Problems and Solutions, Tri-State Delta Chemical Co., Clarksdale, MS, March 1992.

Scott, W. P. Made two presentations at grower/consultant meetings, Shreveport, LA, March 1992.

Scott, W. P. "Cotton pests in the Mid-South." Symposium, Rhone Poulenc Ag Co., Research Triangle Park, NC, March 1992.

Smith, M. T., and B. W. Wood. "Host selection by the blackmargined aphid: Searching for sources of aphid resistance among North American hickory and walnut species." 85th Southeastern Pecan Growers Association Convention, Callaway Gardens, GA, March 1992.

Smith, M. T., B. W. Wood, and R. F. Severson. "Comparative studies of developmental biology, preference and feeding behavior of Monellia caryella on Juglandaceae native to North America." 8th International Symposium on Insect-Plant Relationships, Wageningen, Netherlands, March 1992.

Smith, M. T. "Insect pest management strategies in pecan: Recent advances in biological control, trap cropping and host plant resistance." Mississippi/Louisiana Pecan Growers Association Meeting, Alexandria, LA, June 1992.

Smith, M. T., W. L. Tedders, and B. W. Wood. "Aphid pest management in pecan: Host plant specificity and suitability among North American Juglandaceae." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992.

Smith, M. T., R. C. Gueldner, B. W. Wood, C. C. Reilly, and R. F. Severson. "Host plant selection by pecan aphids: Investigations of host specificity and host suitability." National ESA Meeting, Baltimore, MD, December, 1992.

Snodgrass, G. L. "Distribution of the tarnished plant bug within cotton plants." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992. (Invitation).

Tillman, P. G. "Comparison of functional response of Microplitis croceipes and Cardiochiles nigriceps, parasitoids of Heliothis virescens." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992.

Tillman, P. G. "Development of Microplitis croceipes, Microplitis demolitor and Cotesia kazak on Heliothis zea and Heliothis armigera. National ESA Meeting, Baltimore, MD, December 1992.

Weathersbee, A. A., and D. D. Hardee. "Seasonal abundance of the cotton aphid, Aphis gossypii Glover, and associated biocontrol agents on six cotton cultivars." 39th Annual Miss. Insect Control Conf., Mississippi State, MS, November 1992.

Weathersbee, A. A., and D. D. Hardee. "Effect of cotton cultivar upon cotton aphid, Aphis gossypii Glover: Density, distribution, and life table statistics." National ESA Meeting, Baltimore, MD, December 1992.

4. Other Reports

Hardee, D. D., J. E. Powell, J. R. Coppedge, and R. M. Faust. Heliothis/Helicoverpa Workshop: Revised National Suppression Action Plan. ARS-Wide Working Conference, San Antonio, Texas, September 16-19, 1991. USDA-ARS, 74 pp. February 1992.

IV. Planned Research for Calendar Year 1993

A. Narrative

1. In-House

Studies on a new baculovirus (celery looper virus) having a broad host range will continue through laboratory bioassays against tobacco budworms, cotton bollworms, and other available insect hosts. These bioassays will also determine the effect of infection enhancers on infection rates and the lethal times associated with various hosts. (M. R. Bell)

Cage and infection studies will be conducted whereby the early season weed hosts of lepidopterous pests in the Mississippi Delta are treated with various entomopathogenic viruses, including the baculovirus from the celery looper. The objective of these studies will be to determine the effectiveness of the new viruses compared to *Baculovirus heliothis* in reducing the emergence of tobacco budworm and cotton bollworm moths from early season hosts, and the effectiveness of the new, broad host range viruses on reducing the emergence of other pest species. The viruses will be applied by hand to caged areas and the effect on the first seasonal generations of will be evaluated. Natural and artificially infested areas will be tested. Bioassays will be used to examine the persistence of the viruses used in these tests. If laboratory studies demonstrate increased infection due to the addition of blancophor, the enhancer will be tested on the early season hosts as well. (M. R. Bell)

Considering the possible use of the new virus in future large area treatments, studies will be conducted in the laboratory to examine the most efficient methods and hosts for the mass production of that pathogen. Various hosts being reared in the laboratory will be examined to determine the greatest yield at the lowest cost. (M. R. Bell)

A small plot field trial will be conducted to examine the effect of various pathogens, combinations of pathogens, and combinations of pathogens plus enhancers, on the control of lepidopterous pests of cotton. (M. R. Bell)

The potential for development of cross-resistance patterns in *Heliothis virescens* will be evaluated. The parameters of the increasing resistance by *H. virescens* to endosulfan will be evaluated. In Australia, inheritance of resistance to endosulfan in *H. armigera* was recently found to be sex linked. Cross-resistance to other cyclodienes (dieldrin, aldrin) and inheritance of resistance to cyclodienes in *H. virescens* will be studied. (G. W. Elzen)

We will evaluate the additivity or synergism of mixtures of insecticides applied for control of tobacco budworm and the effect of low and high dose mixtures of B.t.'s with conventional insecticides. Currently, many producers are using untested mixtures in attempts to control insecticide resistant populations of Heliothis. (G. W. Elzen)

Monitoring resistance levels in Heliothis will continue using a variety of insecticide bioassays. Resistance management plans depend on current information regarding trends in the development of resistance in field populations. (G. W. Elzen)

Evaluation of alarm pheromones will be attempted in greenhouse, small plot, and large field evaluations depending on the number and quantity of available candidate materials. (D. D. Hardee, A. A. Weathersbee)

Studies will be initiated on evaluating environmental effects on development of Neozygites fresenii in the cotton aphid, where it overwinters, and modes of transport to aphids in cotton fields. (D. D. Hardee, A. A. Weathersbee)

The Stoneville Research Quarantine Facility (SRQF) will continue to receive in-coming shipments from ARS personnel of biological control agents for the sweetpotato whitefly, Bemisia tabaci. Preliminary studies with these agents will be conducted in the SRQF which will then ship specimens to designated personnel after necessary clearance procedures are done. (D. D. Hardee, F. M. Williams, M. T. Smith, W. W. Bryan)

Willye Harrison-Bryan will continue Ph.D. graduate study at Virginia Polytechnic Institute and State University, Blacksburg, VA. The dissertation research is on examining factors which influence diapause in Microplitis croceipes. The research is designed to gain information to improve Helicoverpa zea control in soybeans in Virginia and cotton in Mississippi. Her research will continue to be conducted at the SRQF and Tidewater Agricultural Experiment Station, Suffolk, VA. (W. W. Harrison-Bryan)

The Stoneville Insect Rearing Research support group will maintain eleven insect species in 1993. These are tobacco budworm, tobacco budworm sterile hybrid BC, bollworm, soybean looper, beet armyworm, velvetbean caterpillar, greater wax moth, Cardiochiles nigriceps, Microplitis demolitor, Microplitis croceipes, and Cotesia kazak. Also, assistance in maintaining insecticide resistant strains of several species will be provided to individual scientists. Artificial diet will be supplied in 30 ml plastic cups and 3.8 liter multicellular trays. Efforts will continue to produce high quality diets and insects at economical prices. The research of approximately 150 scientists within USDA-ARS, private industry, and state universities will be supported by the work of this group. (G. G. Hartley)

The Insect Distribution Programs with the Cotton Foundation and the American Soybean Association will continue in 1993. The Cotton Foundation program is expected to remain consistent with the previous year while moderate growth is expected for the American Soybean Association program. Funds provided by these programs will be used to offset rearing expenses of the Southern Insect Management Laboratory. Prices for insects will remain the same for the present, but both programs will be evaluated to determine if a price increase is needed to keep pace with rearing expenses. The egg and pupal stage of the following species will be available: tobacco budworm, bollworm, beet armyworm, soybean looper, velvetbean caterpillar, and Microplitis croceipes (cocoon only). (G. G. Hartley)

The Stoneville Insect Rearing Group has maintained reproductive colonies of the tobacco budworm sterile hybrid backcross since December 2, 1991. This colony will be expanded in early January 1993 in preparation for a 1993 sterile backcross release of 80,000-100,000 moths per day over a six-eight week period. The Stoneville group will rear both the tobacco budworm and the sterile backcross and perform the required pupal sexing to supply approximately 2,000 female BC pupae and 2,000 male TBW pupae per day to the Gast Rearing Laboratory at Mississippi State, MS. The Gast Lab will emerge the pupae, mate the adults, collect eggs, and implant the eggs in disposable trays of diet. The egg-implanted trays will then be returned to Stoneville where they will be held for development and subsequent field release. (G. G. Hartley)

The distribution of Heliothis/Helicoverpa spp. will be studied on host plants, including cotton, corn and soybean, and population fluctuations correlated with annual climatic conditions. (D. E. Hendricks)

We will develop techniques and optimize methods for sampling and detecting insect populations in field conditions, and monitoring their densities and dispersal habits. (D. E. Hendricks, J. Willers, B. Hickling)

The population density fluctuation patterns of bollworm and tobacco budworm eggs, larvae, and moths will be studied and correlated with environmental factors prevailing in typical agronomic conditions. (D. E. Hendricks)

Cooperation will continue in research to determine the origin of dispersing Heliothis/Helicoverpa spp. populations by genetic characterization of DNA and isoenzyme loci found in unique populations throughout the southern U.S. (D. E. Hendricks, K. Narang)

We will formulate and bioassay bioactive materials, including attractants, disruptants, or attracticides affecting mortality or the behavior of bollworm and tobacco budworms on cotton, other agronomic crops, and wild host plants. (D. E. Hendricks)

Studies will be initiated to use sound to determine the behavior of foliar feeding insects which damage soybean. (L. Lambert, T. Forrest)

Studies will be continued to determine if the genetic removal of soybean plant pubescence enhances the resistance levels of soybean genotypes with foliar feeding resistance to all species of foliar feeding insects. (L. Lambert, T. C. Kilen)

Studies will continue to determine if plant pubescence influences the effectiveness of B.t. and other pesticides. (L. Lambert)

Studies to determine the influence of soybean plant maturity on insect resistance will be expanded to determine if resistance levels decrease during the fruiting phase or if they increase to a higher level in late maturing genotypes. (L. Lambert, E. Hartwig)

Studies will be continued to determine if a practical method can be developed for using an insect virus to control soybean insects. (L. Lambert, J. E. Mulrooney)

Evaluations of the USDA-ARS soybean germplasm collection will continue in an effort to identify resistance to the velvetbean caterpillar. (L. Lambert, T. C. Kilen)

The second year of a pilot test to suppress the tobacco budworm with sterile backcross releases will be conducted in 1993. In 1993 releases will be made in the same manner as 1992 except that the control and release areas for 1992 will be switched for 1993. Plans include releasing 100,000 moths per day from pupae placed at 25 release points over the area. Pupae will be held until initiation of emergence before placing in the field and will remain in the field 16 days instead of 14 (the 1992 duration). Insects will be grown on a diet containing red dye to serve as an initial marker for identifying released moths. The insects will be grown in the R. T. Gast rearing laboratory at Mississippi State and transported to Stoneville for release. Wire cone traps will be used to determine released:wild moth ratios and to monitor sterility ratios for the June and July generations. Egg and larval collections will also be taken from the release and control areas to determine the species complex of the populations and detect differences in population levels in the center of the release area compared to those progressing away from the center. The data will be used to determine H. virescens populations as a function of distance from the center of the release area. (M. L. Laster, D. D. Hardee)

The Helicoverpa zea sterile hybrid project will continue with crosses between H. zea and exotic Helicoverpa species. Establishment of a laboratory colony from a recent collection of Helicoverpa from Indonesia will be attempted. If established, the species will be positively determined and crossing studies with H. zea will be initiated. If cross matings are successful, the study will be carried through the fourth backcross generation and the presence or absence of genetic sterility will be determined. Other exotic species will be tested as they become available. (M. L. Laster, D. D. Hardee)

Heliothis subflexa larvae collected in 1991 were not established in the laboratory sufficiently to conduct studies planned for 1992. Larvae were again collected in 1992 and establishment of a laboratory colony will be attempted. If a working colony is established, the progeny will be mated with H. virescens to obtain hybrid and backcross progeny. These progeny will be compared with the parents to determine the preference and development of specified endoparasitoids. Data obtained will be used to determine if the parasitoids might have a significant impact on released backcross insects for tobacco budworm suppression. (M. L. Laster, P. G. Tillman)

The IRRU will maintain colonies of Anthonomus grandis grandis, Heliothis virescens, Helicoverpa zea, Microplitis croceipes and Catolaccus grandis for mass rearing research and production service. Diet preparation, tray assembly materials, and colony insects will be provided upon request to local federal and state scientists and off-site Cotton Foundation recipients for reimbursement of material/processing costs. An active technology transfer policy will be continued with other insect rearing operations (federal, state, and commercial) to incorporate mechanized production processes within their programs. (J. L. Roberson)

Major mass rearing research programs of the IRRU are as follows: 1) monitoring/modifying egg surface sterilization technique to reduce incidence of microbial infections; 2) increase egg production rates from Heliothis virescens backcross females by modifying handling procedures and environmental conditions; 3) review Catolaccus grandis oviposition processes and modify appropriately to establish protocol for a mass rearing production program; 4) advance current technology for encapsulating boll weevil larvae by increasing sheet size to gain production, output, and labor efficiency; and 5) process diet using the flash sterilizer unit to control microbial contamination and increase shelf life for diet formulation of the Mediterranean fruitfly. (J. L. Roberson)

The IRRU will increase production services to other ARS and ARS/APHIS biological field evaluation programs. It is anticipated that approximately 2.5 million boll weevils (eggs, larvae, and adults) will be shipped to Cotton Foundation recipients throughout the year. In addition, boll weevils, Heliothis virescens, Helicoverpa zea, and Microplitis croceipes insect specimens and diet will be available for ARS, APHIS, and MAFES research scientists for reimbursement of cost. (J. L. Roberson)

Major insect production programs planned for evaluation of large-scale biological control concepts are scheduled as follows: 1) December 28 - February 19, 1993, ten thousand trays per week for a seven-week period to produce 2,240,000 Helicoverpa zea larvae to be used for baculovirus production; 2) March 8 - April 16, 1993, twenty-five thousand trays per week for a six-week production period to produce 4,800,000 Heliothis virescens backcross adults for evaluation of sterile release control concept; 3) February 8 - August 31, 1993, produce 400,000 Catolaccus grandis parasites for assessment of field control; 4) Prepare various lepidopterous diet formulations for shipment to Bozeman, Montana, to evaluate for assessment as artificial diet for insects feeding on leafy spurge plants. (J. L. Roberson)

Studies will continue on narrow row cotton, including effect of row spacing on insect populations and temik effectiveness. (W. P. Scott)

More detailed studies will be conducted to determine differences in tarnished plant bug populations in both narrow and normal row spacings of cotton. (W. P. Scott, G. L. Snodgrass)

Spray table and small field plot studies will intensify to help develop new chemistry showing promise on several cotton pests. (W. P. Scott)

Large field plots will be used to evaluate deltamethrin in more detail in controlling populations of the bollworm, boll weevil, and other cotton pests. (W. P. Scott)

Investigations to elucidate the mechanism(s) which govern the host specificity of Monellia caryella, Monelliopsis pecanis and Melanocallis caryaefoliae among the hickory and walnut species native to the United States, as well as among the pecan cultivars, will continue. Comparative analysis of the foliar cuticular chemistry of pecan, the other hickory and walnut species, as well as the various pecan cultivars will continue and be expanded to include the intracellular and phloem tissues. (M. T. Smith, R. F. Severson, B. W. Wood, R. C. Gueldner)

Investigations of the potential role of leaf surface morphology in host plant resistance among the Juglandaceae and the various pecan cultivar will continue. (M. T. Smith, R. Paul)

Behavioral bioassays will be conducted to determine the role of specific foliar chemistries in the host recognition behavior of the three pecan aphid species. Furthermore, behavioral bioassays (via artificial diet procedures) and electronic feeding monitor analyses will be conducted to determine the role of specific foliar internal chemistries (i.e. phloem and/or intracellular) in the host acceptance behavior of the three pecan aphid species, and which govern the host suitability for aphid growth and reproduction. (M. T. Smith, R. F. Severson, R. C. Gueldner)

Investigations will be expanded to determine the utility of trap crops (sequentially attractive) designed to intercept migrating insect pest species as they move from soybean to pecan and between cotton and pecan. (M. T. Smith, G. L. Snodgrass)

Research designed to re-evaluate the hickory shuckworm sex pheromone will be continued. Additional chemical analysis and field bioassays are planned for the spring moth flight in 1993. (M. T. Smith, G. Greis, M. Hall)

Investigations of the sexual cycle of _Monellia caryella_, will be initiated and include: (1) studies of the cues which control the induction of the sexual cycle; and (2) studies of the semiochemical cues which might function in _M. caryella_ mating behavior. (M. T. Smith, W. L. Tedders, R. F. Severson, R. C. Gueldner)

Monellia caryella seasonal dynamics as it relates to the interactions among the pecan tree, the aphid herbivore and key environmental factors will be undertaken. In this context, field and colony aphids, field and greenhouse pecan foliage, and field and environmentally controlled chamber conditions will be compared in a complex matrix design in order to determine the factor(s) which govern the mid-season _M. caryella_ population crash. (M. T. Smith, W. L. Tedders)

Behavioral studies of the adult green lacewing, as it relates to its feeding and ovipositional behavior, will be initiated. The objectives of these studies are to understand what factors govern lacewing movement in a pecan orchard:cover-crop system. (M. T. Smith, W. L. Tedders)

Insect:plant:parasitoid interactions of the sweetpotato whitefly, _Bemesia tabaci_ (Gennadius), will be investigated within the context of biological control. More specifically, host finding and host selection processes of various parasitoid species of _B. tabaci_ will be investigated in a comparative study of a wide range of its known host plant species. Natural enemy developmental biology, feeding behavior, oviposition and searching behavior will be investigated. (M. T. Smith, F. M. Williams)

An alfalfa field located in the edge of the Mississippi Delta near Holcomb, Miss. will be intensively sampled to determine if a braconid parasite, _Peristenus digoneutis_, of tarnished plant bug nymphs became established after release of adults of the parasite in the field in 1992. Weedy areas within 2-3 miles of the field will also be sampled for the parasite. Parasitism rates will be determined by dissection of nymphs. Nymphs will also be reared to obtain adult parasites. Additional adult parasites will also be released if they are available. (G. L. Snodgrass)

The within plant distribution of the tarnished plant bug in cotton will again be determined as in 1992. Results will be compared to the 1992 data, and the distribution data from both years will be used along with data from efficiency studies on the sweep net to develop an accurate method for correcting counts of adults taken with a sweep net in cotton. (G. L. Snodgrass)

Experiments on sampling tarnished plant bugs in cotton will be conducted in 1993. These include the use of marked adults in field cages to study the capture efficiency of the sweep net for adults. Emphasis will be on how capture efficiency changes for adults on different plant parts, and how it changes as the plants increase in size. A replicated field test comparing the capture efficiencies of the drop cloth, sweep net, and an absolute sampling method for tarnished plant bugs will also be conducted. (G. L. Snodgrass)

Due to a high number of insecticide applications for control of _Heliothis virescens_ and _Helicoverpa zea_ in cotton in the Mississippi Delta in 1992, resistance levels in the tarnished plant bug to insecticides will be determined in 1993. Previous data are available on resistance levels in plant bugs in the Delta to the organophosphorus insecticides, acephate and dimethoate. Resistance to dimethoate will again be determined and resistance levels to pyrethroids will be established using a glass vial bioassay. (G. L. Snodgrass)

Winter laboratory studies will be conducted on interspecific host discrimination and larval competition among Cotesia marginiventris, C. nigriceps and Microplitis croceipes, resistance of C. nigriceps to commonly used cotton insecticides, and intraspecific host discrimination and larval competition of C. grandis. Effect of honey water on survival of M. croceipes colony will be determined. (P. G. Tillman)

Field studies in 1993 include: effect of host density, cage size, female density and time on functional response of M. croceipes, C. nigriceps, C. marginiventris, Microplitis demolitor and Cotesia kazak; comparison of parasitization of H. zea and H. virescens-H. subflexa hybrid by M. croceipes in large field cages; effect of decrease in solar radiation on parasitization by C. nigriceps; observing functional response of C. grandis at high host densities; and evaluate the finding that a single M. croceipes female parasitizes 5 hosts per day in the field while a single C. nigriceps female parasitizes 6 hosts per day in the field. Females will be released in 1/10th acre plots at host densities equivalent to the economic threshold for the host. Two cotton varieties, MD51 (smooth, nectariless and DP50 (smooth, nectaried) will be used to determine if any differences in parasitization occurs for these parasitoids. Populations of plant bugs, boll weevils and bollworms will be monitored. Females of C. grandis will be released to study the efficiency of these parasitoids in parasitizing the boll weevil. (P. G. Tillman)

Host-plant resistance studies will continue with emphasis on understanding the mechanisms by which some cotton genotypes exhibit reduced cotton aphid susceptibility as compared to others. Comparisons among isogenic lines of specific cultivars will be used to determine those plant characteristics imparting resistance. Comparisons will be made in the field under conditions which are typical for commercial cotton production in the region. Cotton aphid natural enemies and other insect pests will be monitored as well. (A. A. Weathersbee III, D. D. Hardee, W. R. Meredith)

The impact of cotton aphid upon cotton yield will be studied in the field. An aphid density gradient will be established among treatments by regulating the activity of a naturally occurring, cotton aphid entomopathogen, Neozygites fresenii, without impacting the densities of other pests. Data for aphid density and plant growth will be taken periodically during the season. Cotton yield will be measured at the end of season. Additionally, other pests will be monitored periodically to assure they were not impacted by methods used to manipulate aphid density. The effect of aphid density on cotton yield will be assessed by regression analysis. (A. A. Weathersbee III, D. D. Hardee)

Field studies will be initiated to develop methods for augmenting activity of the entomopathogenic fungus, <u>Neozygites fresenii</u>, against cotton aphid. The major objectives are to insure pathogen establishment and enhance initial transmission, thereby increasing the rate of epizootic development in the field. Aphid density and plant canopy humidity will be manipulated in field cages to provide conditions suitable for pathogen establishment and proliferation. Once established, cages will be removed to expose infected aphids to the remainder of the field population. Apparently, the pathogen disperses via the alate form of its host. This hypothesis will be tested during the study. Augmentation will be attempted in 3 cotton fields and 3 additional fields will be used as checks. Aphids will be sampled periodically from augmented and check fields to determine if differences exist in entomopathogen infection levels and timing of disease epizootics. (A. A. Weathersbee III, D. D. Hardee)

We will continue to receive and evaluate exotic natural enemies in the Stoneville Research Quarantine Facility (SRQF). Natural enemies will be reared through at least one generation, identified and released to cooperators or held for quarantine study in the SRQF. Importations will be documented and voucher specimens maintained. (F. M. Williams)

The SRQF will continue to receive and document exotic <u>Heliothis</u> in support of the bollworm sterile hybrid project. Protocol and safe handling of pest species in the Maximum Security Area of the quarantine laboratory will be maintained. Reports will be compiled and disseminated to quarantine and regulatory officials on the state and national level. Voucher specimens will be preserved and representative numbers will continue to be shipped to the state and national museums. (F. M. Williams)

2. <u>Extramural</u>

Studies are to be conducted to enhance current detection procedures of the nonoccluded baculovirus in all life stages of <u>Microplitis croceipes</u>, i.e., larvae, pupae, adult. (P. P. Sikorowski, J. L. Roberson)